The Role of CSP and PV for the MENA-Region
Against or complementary?

kfw Energy Sector Seminar 2012

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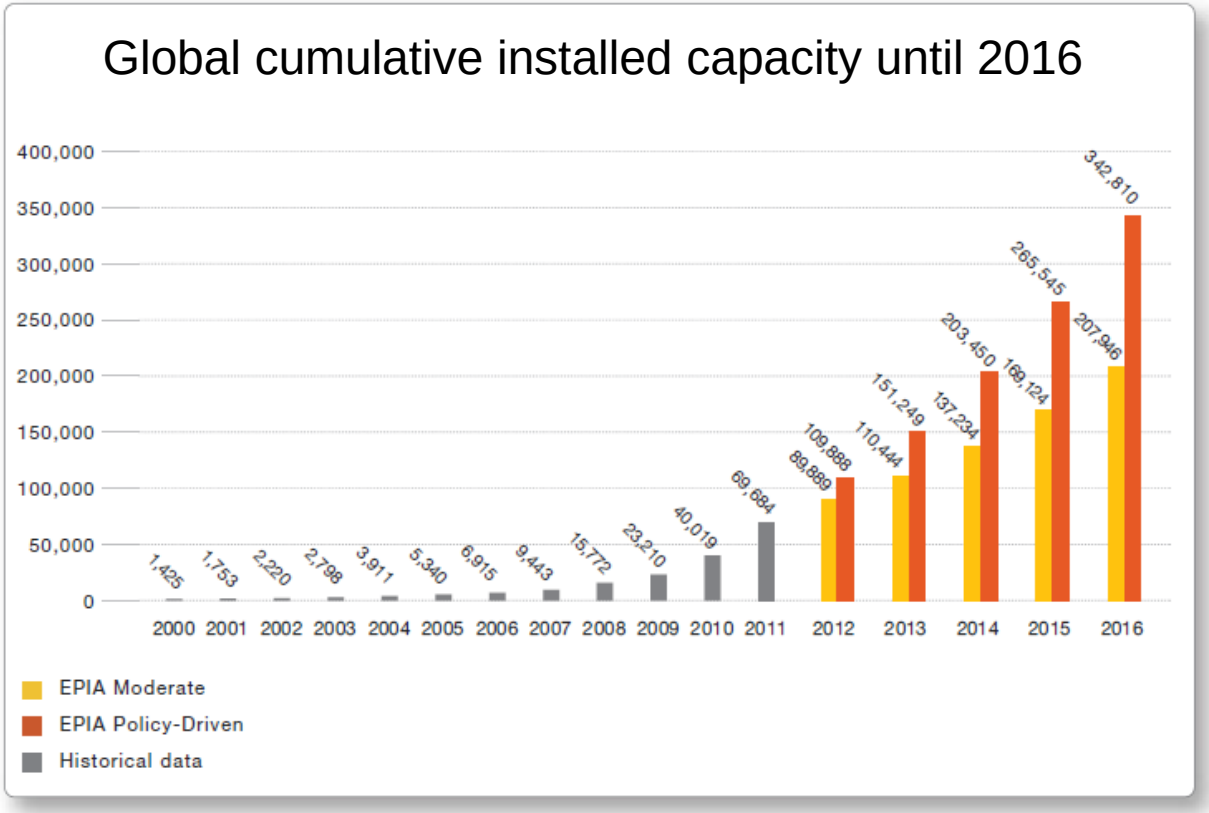
Agenda

- Present situation of PV and CSP
- How to compare PV and CSP?
- PV vs. CSP or PV & CSP: A case study for Jordan

PV – the situation



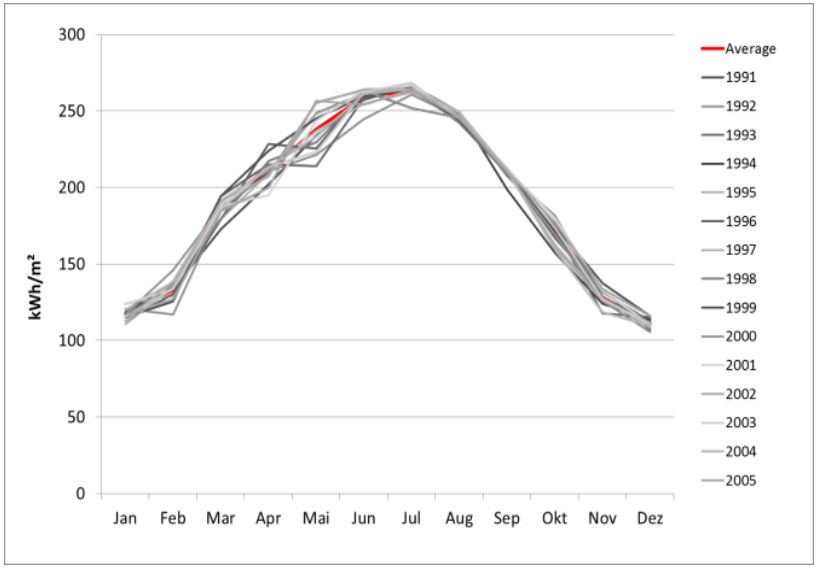
- Strong market growth
- 2011: 30 GW new installed
- High share of Si- PV
- Heavy price competition
- Ca. 50 % price decrease of PV-systems during last 5 years
- 4000 – 12000 MW in MENA till 2016 expected

Source: EPIA – Global Market Outlook 20016

PV – characteristics

- PV is a non-dispatchable power generation technology since power output is directly linked to the temporal availability of the solar resource (GHI).
- However, GHI availability is quite predictable in the MENA region and inter-annual variation is low.
- PV is an interesting options to cover parts of the mid-day peak demand whereby expensive fuel for peak load generation can be saved

Monthly average values of GHI for the years 1991 - 2005
at a selected site in Southern Jordan

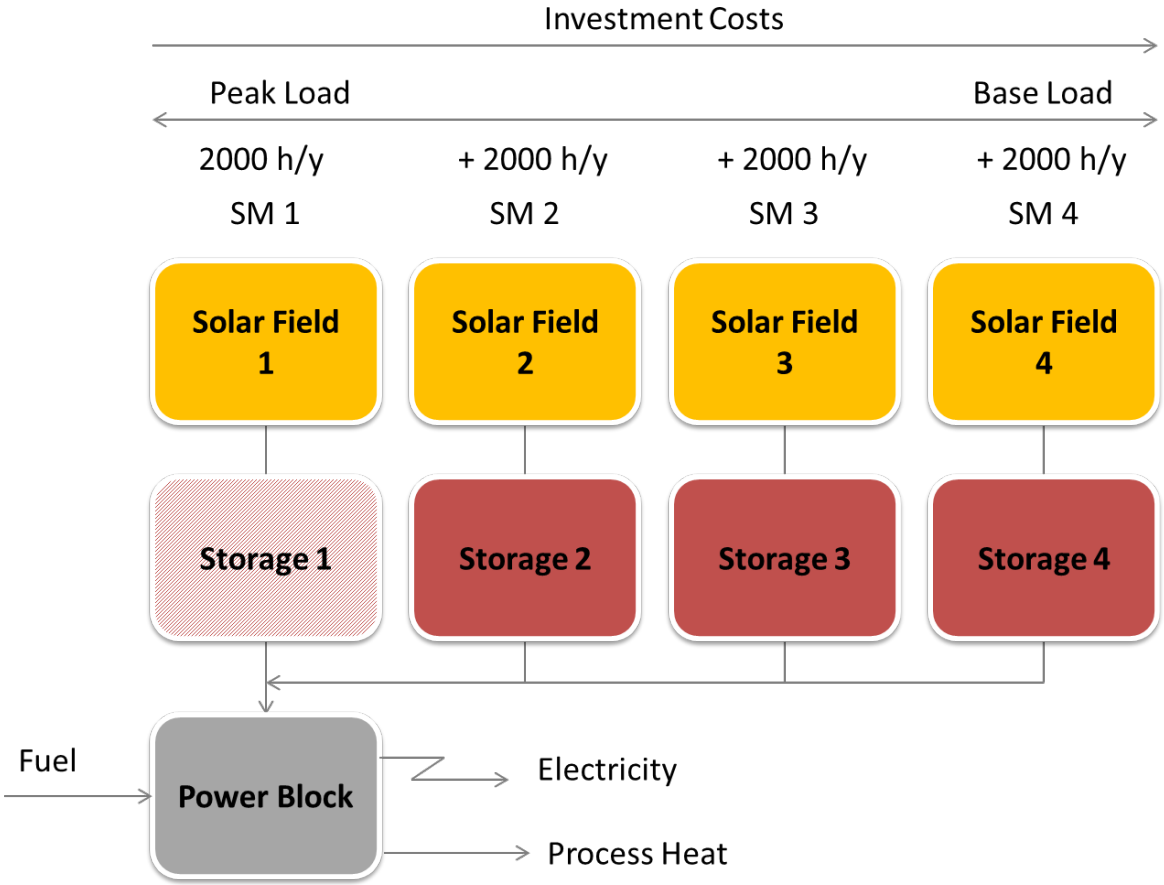


Source: DLR 2012 (SOLEMI)

CSP – the situation

- Ca. 2 GW installed in the mid of 2012
- About 1.6 GW installed since 2007
- Further 5 GW online till 2014/2015
- Strong decrease of investment costs in the next five years expected since market size exceeds critical limit
- Parabolic Trough technology most utilized technology option (about 70 % of all installed and under construction projects)
- However, especially the Solar Tower but also the Linear Fresnel technology catches up
- Challenged by strong decrease of PV-system and generation costs

CSP – characteristics



Qualities of CSP Plants:

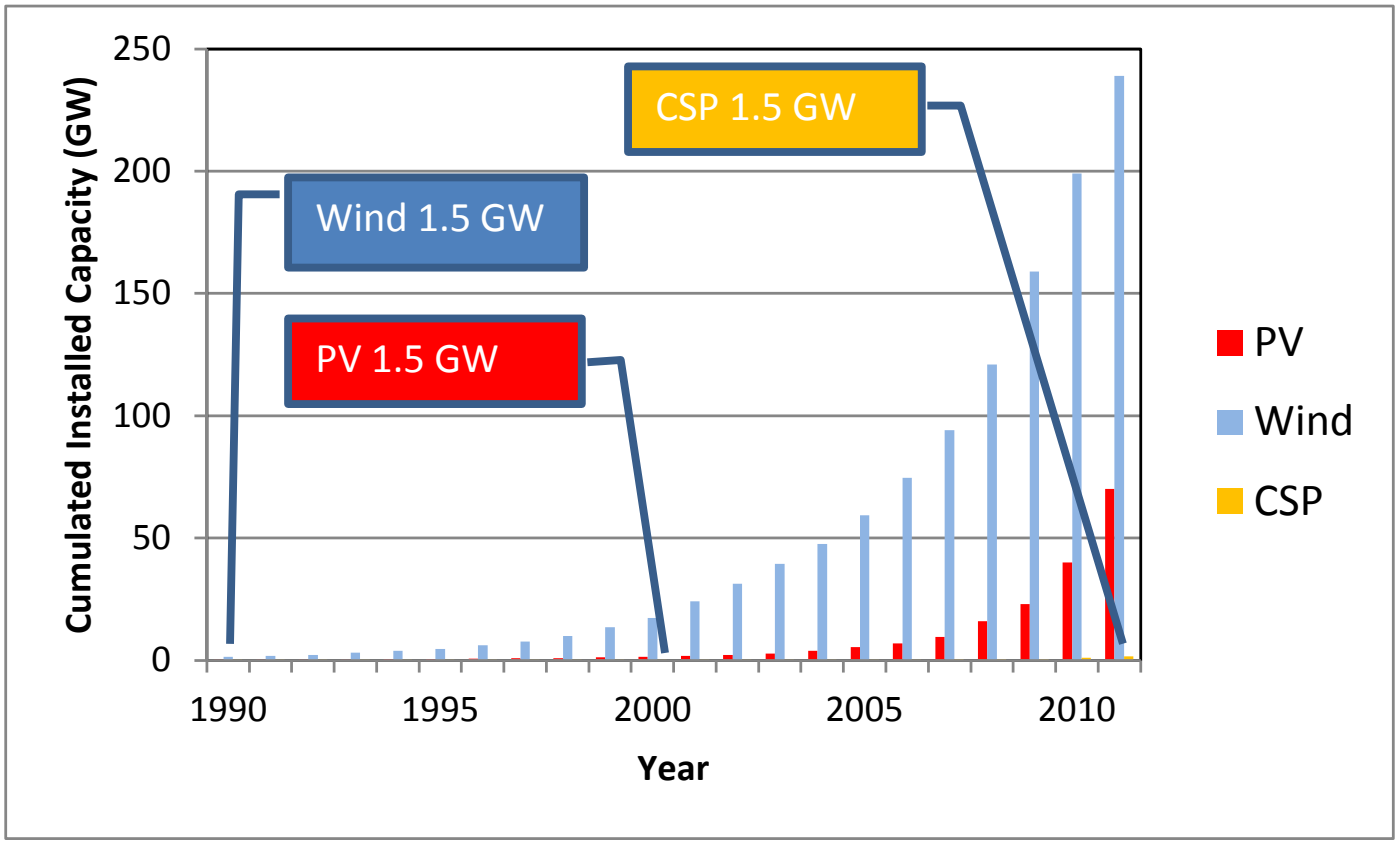
- Operating as peak, medium or base load power plant
- Firm & flexible capacity
- Power on demand
- System services (reserve capacity)
- Combined generation of process heat for industry, cooling, desalination, etc.

Overview

	Utility-scale PV	CSP
Global installed capacity	70 GW	2 GW
Specific investment costs	2012: 1500 – 1700 €/kWp 2015: 1250 – 1450 €/kWp	2012: 2900 – 11000 €/kW 2015: 2400 – 9000 €/kW
Typical electricity costs	2012: 0.08 – 0.22 €/kWh 2015: 0.07 – 0.18 €/kWh	2012: 0.16 – 0.23 €/kWh 2015: 0.13 – 0.18 €/kWh
Typical plant size	0.2 – 100 MW	20 – 500 MW
Typical capacity credit	0 %	0 – 90 %
Typical capacity factor	5 – 25 %	20 – 90 %
Project implementation time	3 – 4 y	4 – 5 y
Advantages	- low generation costs - fast construction time - highly modular - high cost reduction potential	- dispatchable - firm and flexible power on demand - reserve capacity / system services - high cost reduction potential
Disadvantages	- non-dispatchable	- high initial investment costs - longer construction time

Data: ISE 2012, EPIA 2012

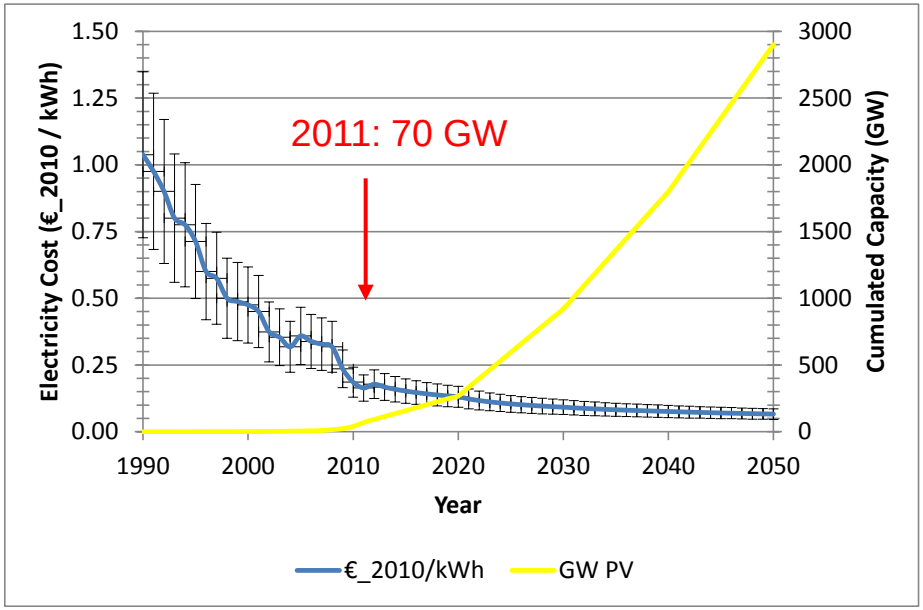
Global Cumulated Wind, PV and CSP Capacity



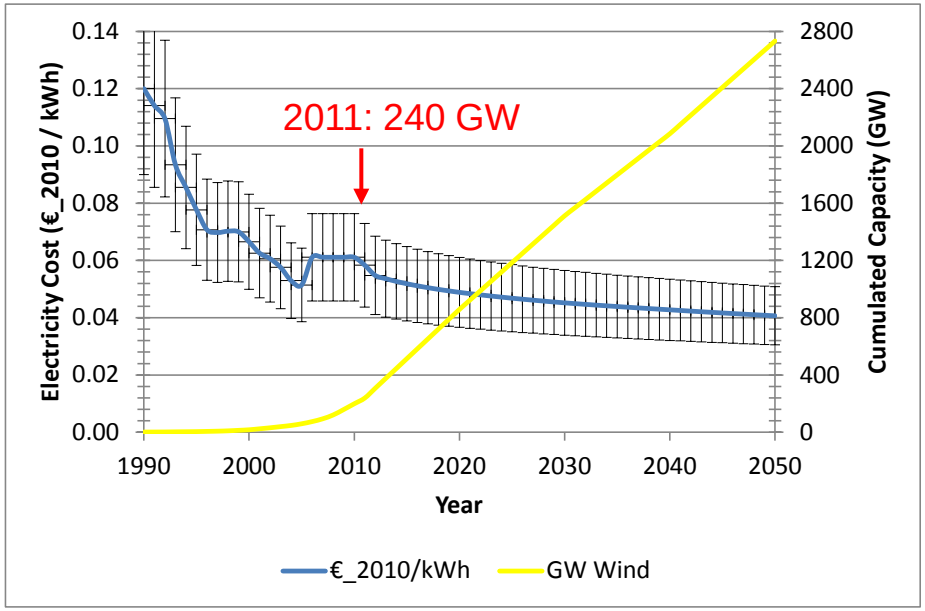
Source: WWEA 2012, EPIA 2012, ESTELA 2012, REN21 2011

To tap renewable energy sources means to invest in their expansion until they become competitive:

Photovoltaics



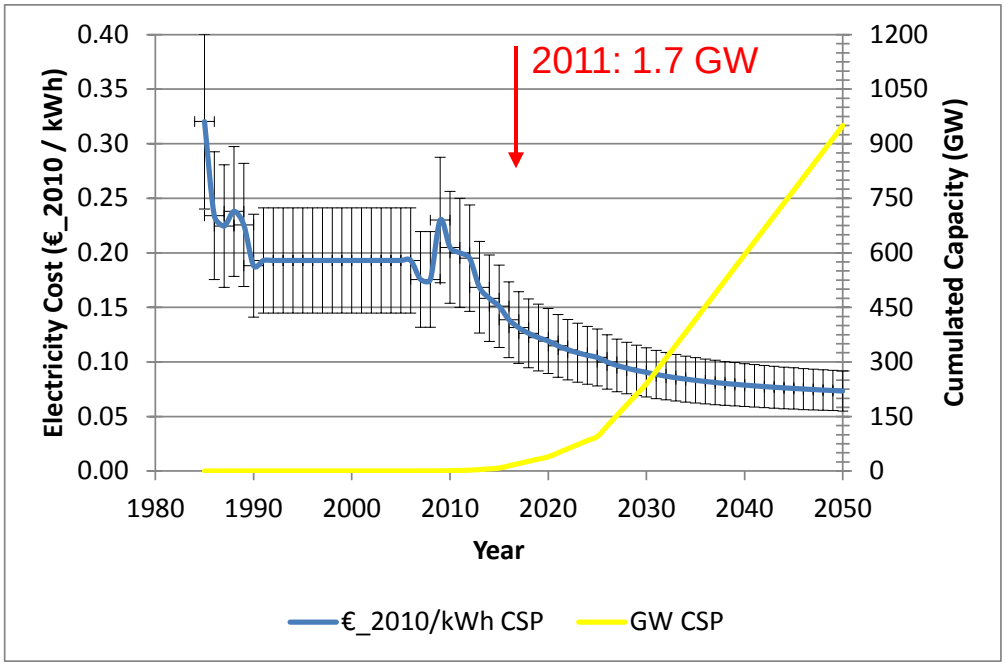
Wind Power (on-shore)



Sources: IER, RISO,WWEA, own calculations
Global expansion according to Energy (R)evolution Scenario, Greenpeace 2010
Learning rates: PV 18%, Wind 10%

To tap renewable energy sources means to invest in their expansion until they become competitive:

Concentrating Solar Thermal Power



CSP at the very beginning of the learning curve!

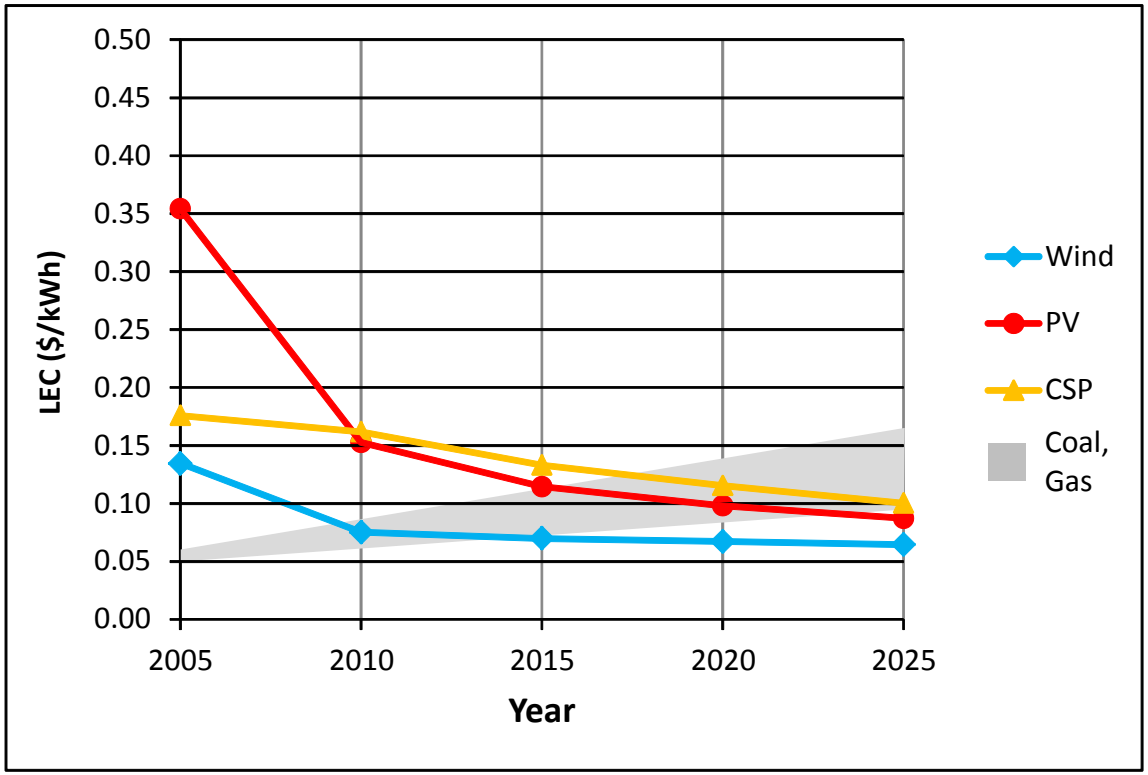
Sources: KJC, Pilkington, DLR, AT Kearney, NREL, IEA, Greenpeace, own calculations
Global expansion according to Trieb et al. 2011
Learning rate: CSP 9%

Cost Comparison of CSP, PV and Wind Power Supply in MENA

- In most cost calculations for PV and wind power, the costs for electricity transport, storage and back up power are not considered.
- In contrast, CSP is a flexible and firm power generating system, depending on the size of thermal storage capacity and back-up system.
- This is a highly relevant advantage for CSP power generation which means a strong added value in comparison to the fluctuating renewables.

CSP, PV, Wind, Fuels: cost of generation

(typical LEC analysis)



Installed capacity: 100 MW

Site: North Africa

Linear fuel cost escalation
as in 2000-2010, market prices

PV 2000 h/y, 30 y
Wind 2500 h/y, 20 r
no storage, no backup

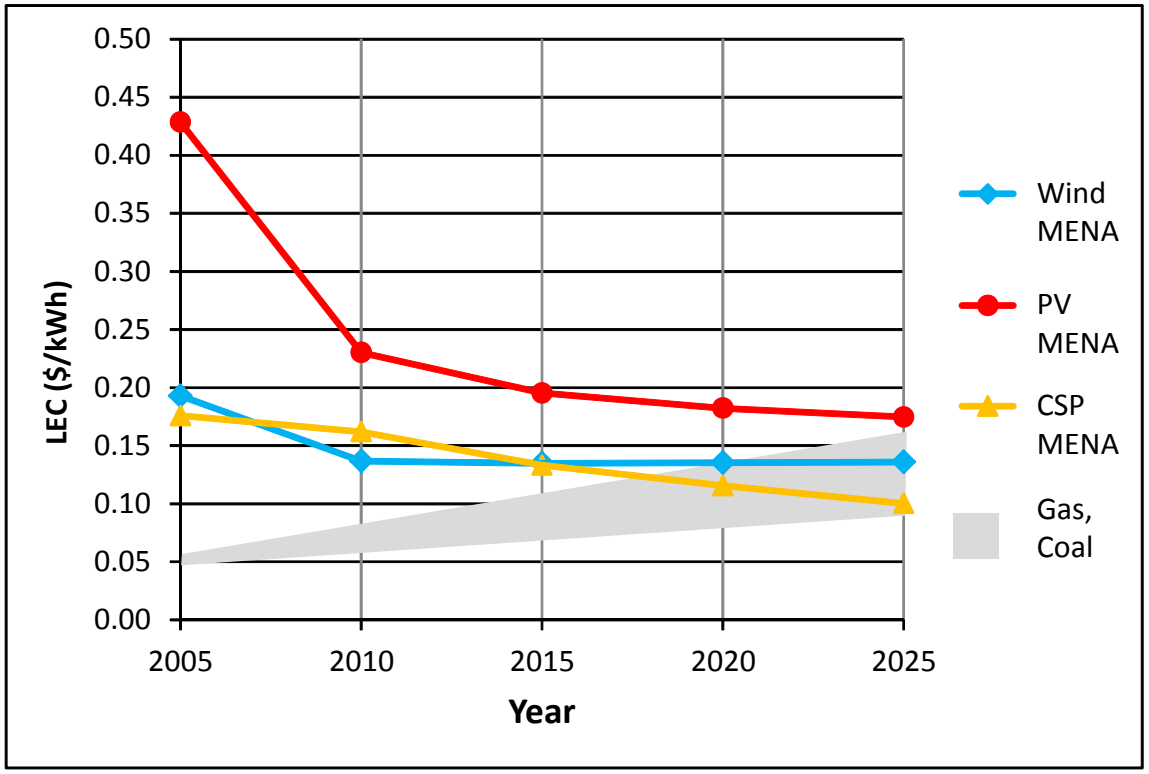
CSP 5500 h/y, 40 y
incl. thermal energy storage
and 10% hybrid operation with
natural gas

LEC = levelized electricity cost

DLR

Source: DLR (Trieb) 2012

CSP, PV, Wind, Fuels: cost of flexible and firm power



Load: 100 MW, 5500 h/y, 40 y

Site: North Africa

Linear fuel cost escalation as in 2000-2010, market prices

PV, Wind incl. pump storage; 10% backup by natural gas combined cycle

CSP incl. thermal energy storage and 10% hybrid operation with natural gas

LEC = levelized electricity cost

Source: DLR (Trieb) 2012

MENA – context

- Strong increasing energy sectors
- High demand of firm and flexible power capacity
- Very good solar and wind resources
- Very limited pump-storage potential
- Partially old and inefficient gas turbines burning expensive Diesel or LFO
- How can renewable energy technologies be integrated efficiently into the existing electricity sectors of the MENA countries by simultaneous maintaining the electricity supply security?

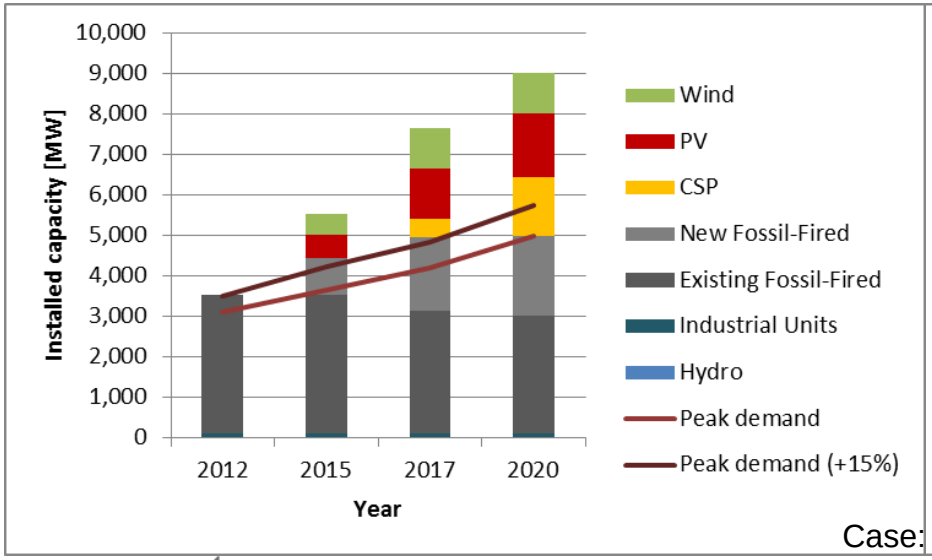
ReMix-MENA:

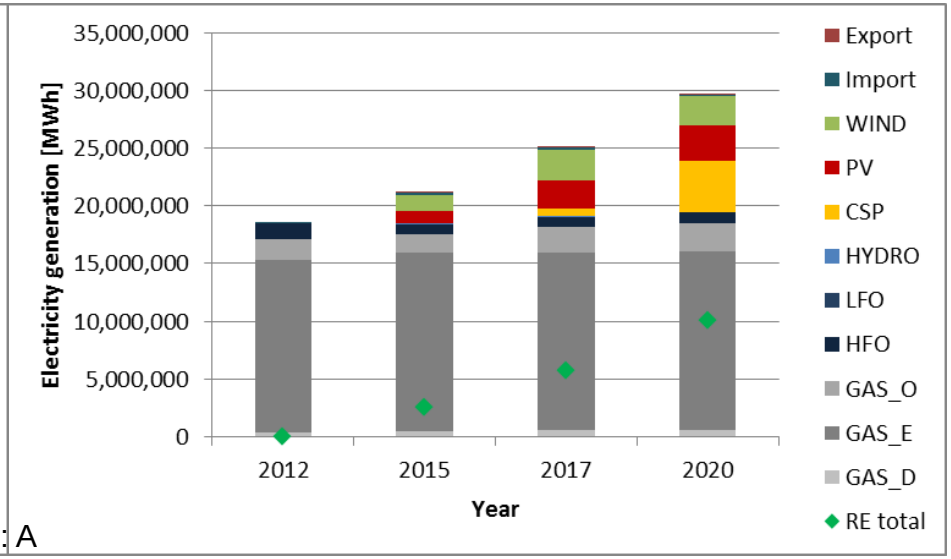
Optimization tool for cost efficient integration of renewable energy technologies in MENA countries

- Model for step-wise capacity expansion, replacement and unit commitment optimization
- Starting from present power plant portfolio of investigated country
- Detailed hourly modeling of technical and economical restrictions and dynamics of conventional and renewable energy technologies (on single unit level)
- Taking into account all necessary system restrictions (firm capacity requirements, spinning reserve, tertiary reserve, etc.)

Optimized integration of renewable energy technologies in Jordan – preliminary results

- PV, onshore wind power and CSP already today competitive in certain load segments
- Until 2017, PV and onshore wind installation replacing expensive fossil fuels (HFO, LFO/Diesel)
- CSP latest from 2017 on main choice for highly required firm and flexible power capacity





Case: A

Source: DLR (Fichter) 2012

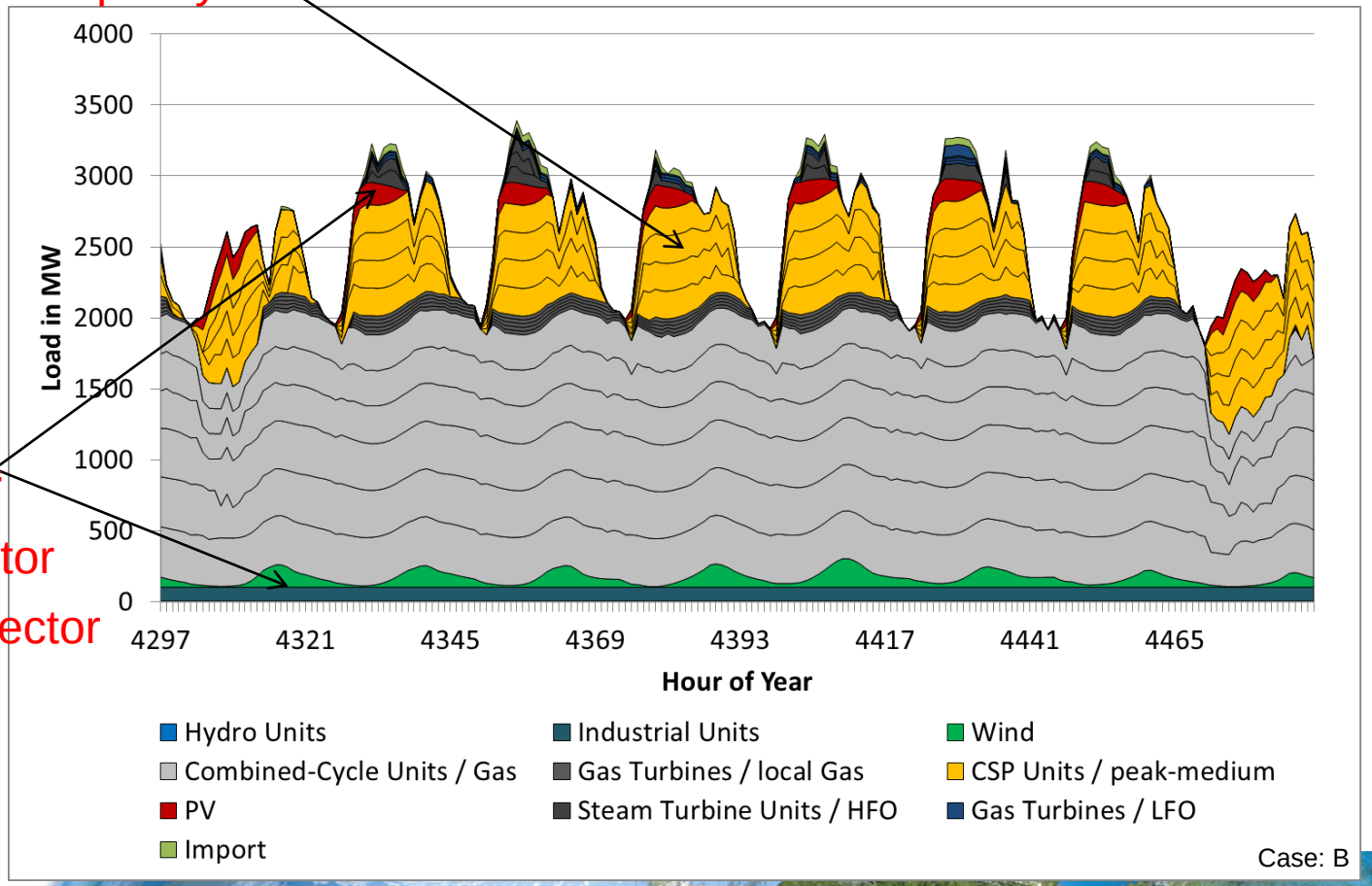
Short- and medium term prospects of PV and CSP in MENA

Case study Jordan

CSP as peak / upper mid-merit power plants providing strongly required firm and flexible power capacity

CSP Configuration:
- SM: 1 - 2
- TES: 3 - 6 h
- Flh: 2000 - 4000

PV and Wind Power as cheap “fuel saver“
- PV: peak load sector
- Wind: base load sector



Source: DLR (Fichter) 2012

Long term prospects of PV and CSP in MENA
Case study Jordan

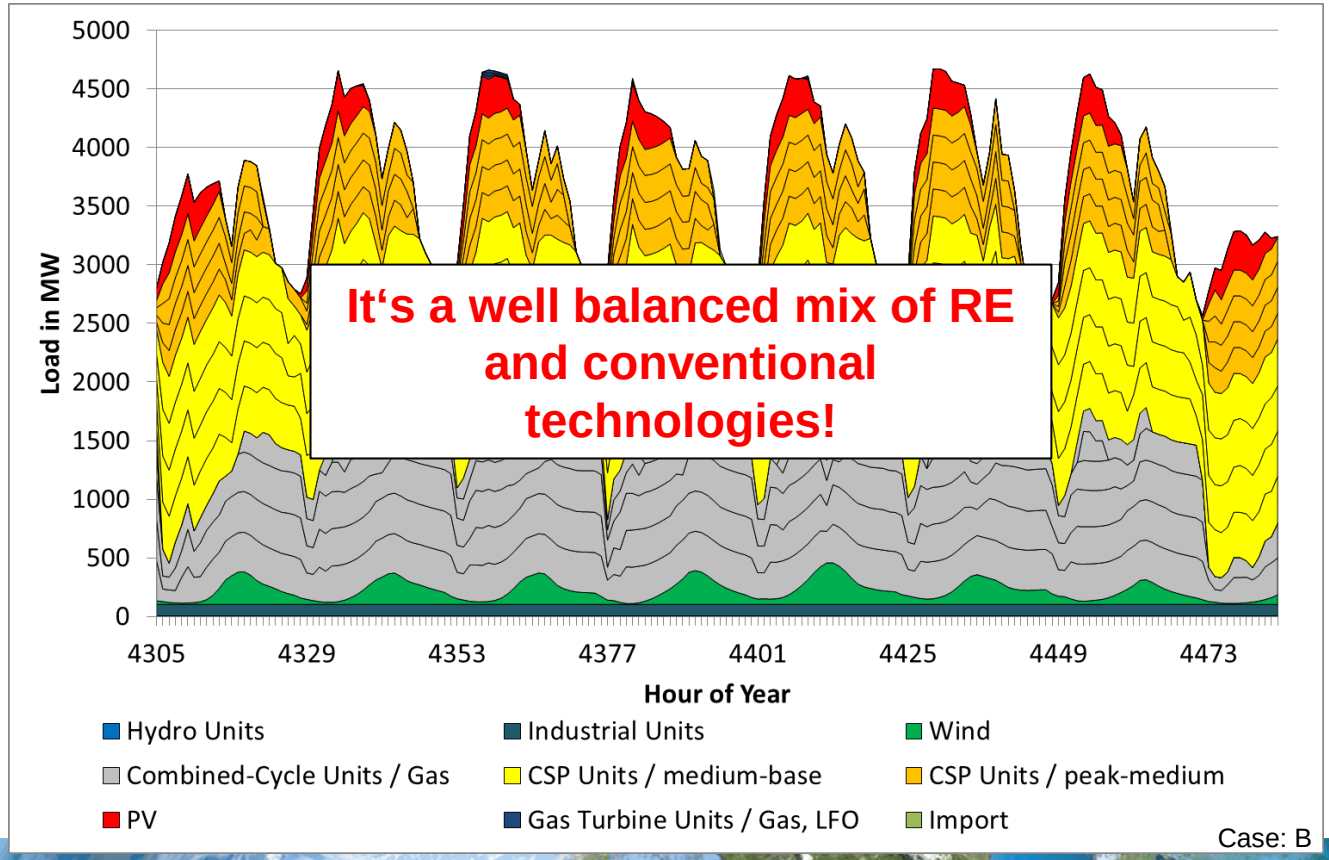
CSP becomes competitive with lower mid-merit and base load segment

CSP as firm and flexible power capacity as backbone of electricity supply

CSP Configuration:
- SM: 2 - 3.5
- TES: 6 - 18h
- Flh: 4000 - 8000

Share of PV and Wind Power further increased

Fossil fuels used for peak load and in high efficient CCGT Units



Source: DLR (Fichter) 2012

Conclusions – 1
General remarks

MENA:

- High potential of solar and wind resources
- Strong increasing electricity sectors
- High need for additional firm and flexible power capacity
- Very limited pump-storage potential
- CSP only alternative for firm and flexible power in MENA except of fossil – fired power plants

- PV and CSP are already competitive in the shot-term
- PV as important cheap “fossil-fuel saver”
- CSP as backbone of electricity supply in MENA countries
- It’s CSP & PV and not CSP vs. PV

Conclusion – 2
Setting an appropriate policy framework

- recognize the need for large RE investment
  (RE investment replaces fuel consumption for decades!)
- reduce capital cost by increasing RE project ratings towards AAA
  (re-insured PPA, guaranteed renewable electricity tariff)
- recompense the quality of flexible & renewable power
  (re-insured PPA, guaranteed renewable firm-capacity tariff)
- provide transparent, long-term stable regulatory and policy framework to trigger real RE markets
- start immediately!

Thank you very much!!!

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